



About the Solar-Energy-Water-Environment Nexus Project

Nevada is second only to Egypt in solar radiance. Meaning, the state has an abundance of solar energy that can be harnessed and turned into useable energy.

While solar energy research and solar panels have come a long way, there is more research to be done – specifically on how to create solar panels that require less water to maintain. With water already a limited resource in Southern Nevada, reducing its involvement in solar energy's evolution will have long-term benefits.

The Solar Nexus project (for short) aims to help Nevada establish itself as a competitive state in the field of solar nexus research. A multifaceted five-year research project, the Solar Nexus Project focuses on solar energy generation and its impacts on the nexus – or linkages – among Nevada's limited water resources and fragile environment. It also focuses on creating a center of research excellence on solar energy conversion to electricity, minimizing its negative impacts on water usage and the environment. Essentially, the project will seek to create a paradigm shift in how solar plants are built and utilized.

Funded by the National Science Foundation (NSF) Experimental Program to Stimulate Competitive Research (EPSCoR) at \$20 million (federal dollars) plus \$4 million (state dollars) over five years, the project began June 1 and ends May 31, 2018. It has four strategic goals in the following areas: 1) solar energy-water-environment nexus research; 2) diversity; 3) workforce development and education; and 4) external engagement.

Unique world-wide in supporting coordinated research on the nexus of solar energy generation with impacts on water resources and the environment, project research involves and/or will benefit the following areas: solar power, engineering, diversity, education, cyberinfrastructure, Nevada economic development and diversification and workforce development, data collection, connectivity, software tools to help scientists, students and decision-makers.

The Solar Nexus Project is a high-tech, highly inter-disciplinary project that brings together a diverse team of hundreds of engineers, educators, researchers and computer scientists and students, including 30 PhD-level students (five from the Desert Research Institute and 25 from University of Nevada, Las Vegas and University of Nevada, Reno). The project should launch more interdisciplinary projects in the future.



RESEARCH

Strategic priority (external engagement): Advance new knowledge and discoveries regarding the nexus among solar energy development, limited water resources and fragile environments.

The Solar Nexus project is conducting science and engineering research in four interrelated areas:

1. Explore new technologies to minimize water use at solar energy facilities
2. Determine desert ecosystem responses at multiple scales to perturbations associated with development of solar energy facilities;
3. Develop advanced and sustainable water/wastewater approaches to support water needs for solar energy development;
4. Improve the development and reliability of renewable and solar energy supply with new interdisciplinary approaches.

The project is in line with Nevada's Science and Technology Plan (developed by NSHE and adopted by the Board of Regents), which identifies seven priority areas for Nevada:

- 1) Alternative and renewable energy
- 2) Water resources and policy
- 3) Technology (including IT)
- 4) Education
- 5) Urban and rural sustainability
- 6) Human health
- 7) Climate change

With high scientific merit, the project has the potential to transform science in this area. Also, many of the scientists from the Desert Sol project, which placed 2nd in the international 2013 U.S. Department of Energy Solar Decathlon, are involved in the Solar Nexus Project.

TECHNOLOGICAL ADVANCEMENTS IN CYBERINFRASTRUCTURE

The Nexus research will be accelerated by enhancing Nevada's cyberinfrastructure (CI) capabilities for data communication, processing, and management, while establishing a new archetype for CI research and development: the Nevada Research and Data Center (NRDC) for data management, communication, and processing. The NRDC will serve the needs of the nexus, other interdisciplinary research and education in Nevada as well as in more broadly dispersed regions.

Additionally, the Solar Nexus project aims to create cyberinfrastructure tools that will help science and education better make sense of research data. The project will increase Nevada's CI capabilities, including advanced data services, real-time data streaming and visualization, data mining and analysis, image processing, data security and cloud computing.



DIVERSITY

Strategic priority: Develop a comprehensive approach that leads to an increase in the number of underrepresented students graduating from STEM (science, technology, engineering and math) programs.

The Solar Nexus Project has an entire team dedicated to diversity. This is unique, as a diversity aspect is often added to such research projects as an afterthought. The Solar Nexus Project has received double the number of applications from minorities (as opposed to previous projects) thanks to its outreach efforts.

Through science, computer infrastructure, water and solar, the Solar Nexus Project aims to broaden participation in STEM research. The project's diversity team is reaching out to all NSHE institutions, including its research institutions, state college and community colleges, to bridge the pipeline for candidates to enter two- or four-year graduate programs. The diversity team is also reaching out to Nevada high school students with the goal of engaging "first-generation students" – those who never previously thought a career in STEM disciplines was an option available to them.

EDUCATION

As part of the Solar Nexus project, Nevada's higher education system has been given money for people and equipment, allowing for new programs, new courses and bringing new faculty into the state. NSHE faculty members will leverage the resources and develop programs that live beyond this research project.

The project is also creating valuable opportunities – such as traveling to Washington D.C. to speak with legislators and presenting their work at statewide conferences – for students. Additionally, it is encouraging students to go to grad school who never thought of it or dreamed it could happen.

EXTERNAL ENGAGEMENT

Strategic Priority: Enable Nevada scientists to collaborate and develop relationships with industry, institutions and the public to strengthen research supporting economic development of Nevada.



About EPSCoR and Nevada EPSCoR

The Experimental Program to Stimulate Competitive Research (EPSCoR) is a national program funded by the Department of Energy (DOE), the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF) and the U.S. Department of Agriculture (USDA).

EPSCoR was mandated by Congress in 1979 to not only promote national excellence in science but also to avoid the undue geographical concentration of federal funding, guaranteeing that all states and regions benefit from the U.S. research investment. The importance of EPSCoR has been elevated in the last decade due to an aging workforce and the United States falling behind global competitors in science and technology. EPSCoR programs recognize the need to draw on all the talents of the United States.

The mission of EPSCoR is to assist the National Science Foundation in its statutory function "to strengthen research and education in science and engineering throughout the United States and to avoid undue concentration of such research and education." Its goals are to provide strategic programs and opportunities for EPSCoR participants that stimulate sustainable improvements in their R&D capacity and competitiveness, and advance science and engineering capabilities in EPSCoR jurisdictions for discovery, innovation, and overall knowledge-based prosperity. (Other agencies are similar but specific to their mission.)

Creating opportunities, EPSCoR provides eligible jurisdictions with funding opportunities to develop a more active research base by involving their academic and research institutions.

Nevada is one of 20 USDA EPSCoR-eligible jurisdictions. EPSCoR Nevada serves as the catalyst for inspiring undergraduate students to go on to earn their master's degrees and PhDs in science, technology, engineering and math. As a result, EPSCoR Nevada students continue on to earn their master's degrees, PhDs, start their own companies and more. Many of them choose to stay in Nevada.

NEVADA NSF EPSCOR AND THE SOLAR NEXUS PROJECT

EPSCoR is a merit-based program. Those submitting for funding must go through a competitive, peer-review process. All eight Nevada higher education campuses are directly affected by the Solar Nexus Project.



Solar energy in Nevada

Nevada is the ideal location for intensive solar energy research because it is second only to Egypt in solar radiance. Considering Nevada is in a drought, research that studies how to reduce the water required to maintain solar panels is aptly suited for the local desert climate.

According to the Natural Resources Defense Council, “Nevada is the fastest-growing state in the country in terms of population -- and in electricity consumption as well. Nevada spent more than \$11 billion on coal, natural gas, petroleum products, and other fuel in 2008, and most of that money left the state.”

A UNLV study for the state's Renewable Energy and Energy Conservation Task Force estimates that generating just 7 percent of Nevada's electricity from in-state renewable sources will create more than 2,500 jobs and generate \$310 million in revenue each year. At 15 percent, the job tally would top 5,000, and annual revenues would reach \$665 million.¹

As part of the Solar Nexus project, a Nevada Environment, Water, several test sites will be chosen throughout the state to conduct potentially transformative research on the environmental impacts and water issues related to solar energy production. The project will bring together engineers, hydrologists, biologists, ecologists, soil scientists, atmospheric scientists and economists, along with national and international collaborations to investigate impacts and new improvements in solar energy generation.

Additional ways the Solar Nexus project benefits Nevada

¹ The information is excerpted from the Nevada Renewable Energy and Energy Conservation Task Force's 2003 Report to the Nevada State Legislature



ECONOMIC DEVELOPMENT

The Solar Nexus Project is a science, engineering and high-tech program based in Nevada that falls directly in line with Gov. Brian Sandoval's Nevada economic development plan, which names seven sectors that the Solar Nexus Project serves: information technology (IT), renewable energy, workforce development, water/environmental, economic diversification, research and education. The plan includes such action items as: "Advance knowledge-based industries through partnerships with higher education."

The plan also states: "A significant factor in the success of Nevada's new economy will be the development and introduction into the market of new products, services, and business models. Working with institutions of higher education, entrepreneurs, investors, and companies, Nevada will make technology-based economic development (TBED) a priority." It also states: "In the meantime, GOED and its RDA partners will help advance knowledge-based industries through partnerships between higher education and targeted sectors" such as: "Innovation and technology commercialization in partnership with NSHE." And: "... sector enhancement will also be achieved through energetically working with community colleges to deliver a skilled workforce and dynamically linking higher education and industries in research collaboration."

The project has potentially many positive economic impacts for Nevada, including:

- Less expensive and, thus, more competitive solar electricity
- Attract solar companies that will take advantage of NEW-STAR's capabilities and expertise
- People trained in the skills needed to enhance the ability of Nevada to meet the qualified staffing needs of solar companies
- Demonstrate to solar companies that the state is eager to collaborate and facilitate work on technical issues
- Demonstrate to companies that performance improvements to solar plants are possible, with this message spreading through the industry
- Assist governmental agencies in better understanding the implications of the solar plant approval process, resulting in a more company-friendly environment for locating operational plants in Nevada
- Foster collaboration with researchers from other arid and sun-rich regions, including Southern Spain, Israel, Western China, North Africa and Australia

The abundant solar flux in Nevada makes the state one of the best sources for solar energy generation in the world. Development of this energy source has the potential to diversify Nevada's economy.



WORKFORCE DEVELOPMENT

Strategic priority: Develop a sustainable STEM workforce by creating a pipeline of STEM-trained students, educators and workers while increasing public understanding of solar energy, water and the environment.

Most people will stay in the state in which they earn their master's degree or PhD. By serving as the catalyst for inspiring undergraduate students to go on to earn a graduate degree, the Solar Nexus Project is helping to keep STEM-educated professionals in Nevada. Through providing industry internships and solar energy technical training, the Solar Nexus Project is providing Nevada-based researchers and students with lifelong skills that will benefit the state. Additionally, a lot of NSF project graduates are launching high-tech startups in Nevada. In Reno, for example, there is a Silicon Valley-type area where they are doing this; it has been dubbed High-Tech Row.



Leadership

DR. BOB BOEHM

Co-PI

One of the co-principal investigators for the Nevada Solar Nexus project, Dr. Bob Boehm will study both high and low temperature aspects of solar thermal power plants. In the high temperature aspect, he will work on high-temperature receiver designs and system consideration for supercritical CO₂ cycles. He will also set up a test rig for evaluating new dry cooling heat transfer surfaces.

Boehm's work is concentrated in three areas: 1) Utilizing a test facility that uses high flux solar dish system for high temperature; 2) A facility to evaluate new heat transfer surfaces for dry cooling will be designed, constructed, and used for a variety of high performance designs; 3) A model of supercritical CO₂ power systems will be developed for analysis of the impact of key parameters.

Boehm is a distinguished professor of mechanical engineering, Dominic Marrocco professor of energy research at the University of Nevada, Las Vegas, and director of the Center for Energy Research. He works in thermal system design and experimental studies related to that area.

DR. JACI BATISTA

Co-PI

As lead scientist for the Nevada System of Higher Education's Solar Energy-Water-Environment Nexus Project, Dr. Jaci Batista is overseeing a project that could change the way solar plants are built.

Batista's research involves technology development for water and wastewater systems using both physico-chemical and biological methods. Batista has participated in multidisciplinary collaborations with microbiologists, geochemists, hydrologists, chemists, metallurgists, and engineers on research for a variety of environmental issues of international and national significance.

She is a member of several professional organizations, including the American Water Works Association, Water Environmental Federation, American Chemical Society, American Society of Microbiology, Nevada Water Environmental Association, Association of Environmental Science and Engineering Professors and is a registered professional engineer and a sought-after environmental engineering consultant to the water industry of California, Nevada and Arizona.



Batista is a professor of Environmental Engineering and The Southwest Gas Professor of Renewable Energy. She earned her Ph.D. in environmental engineering from The Pennsylvania State University has been a member of the UNLV Department of Civil and Environmental Engineering and Construction since 1997.

Funding for her research has come from industry, federal, state, and local agencies, including U.S. Environmental Protection Agency, American Water Works Association Research Foundation, National Science Foundation, Nevada Division of Environment Protection, City of Las Vegas, Clark County Sanitation District, Clark County Health Department, Clark County Flood Control District, Las Vegas Valley Water District, and water utilities in California, Arizona, and Nevada.

DR. GAYLE DANA

Solar Nexus Project

Project Director and State EPSCoR Director, Nevada System of Higher Education

Dr. Gayle Dana oversees all of Nevada's EPSCoR programs in her role as state EPSCoR director and serves as the project director and principal investigator for Nevada's NSF EPSCoR Research Infrastructure Improvement (RII) programs. These include: Nevada's Track1 project on the Solar Energy-Water-Environment Nexus in Nevada and the Track2 Western Consortium for Watershed Analysis, Visualization, and Exploration (WC-WAVE).

Dana is also an associate research professor at the Desert Research Institute, Division of Hydrological Sciences. Her technical competencies include surface water hydrology and energy balance of desert, seasonally snow-covered and polar regions.

Dana holds a doctorate in hydrology/hydrogeology from the University of Nevada, Reno; a master's degree in ecology from San Francisco State University; and a bachelor's degree in zoology from the University of California, Davis.



DR. SERGIU DASCALU

Component Co-Lead

As the cyberinfrastructure (CI) lead, Dr. Sergiu Dascalu will head the CI team's work on enhancing Nevada's CI capabilities for data communication, processing and management while establishing a new archetype for CI research and development.

Dascalu is an associate professor in the Computer Science and Engineering Department at the University of Nevada, Reno. He received a master's degree in automated control and computers from the Polytechnic of Bucharest, Romania and his doctorate in computer science from Dalhousie University, Canada.

Dascalu's main research interests are in software engineering and human-computer interaction, in particular in software specification and design, software tools for scientific research, simulation environments and user interface design. Dascalu is the director of the Software Engineering Laboratory (SOELA) at UNR and has served as PI or co-PI on various projects funded by federal agencies such as NSF, NASA, and ONR, as well as by industry organizations.

Dascalu has more than 120 peer-reviewed publications and has been involved in the organization of many international conferences and workshops, from which he received numerous recognitions. At UNR, he has advised more than 40 graduate students and is the recipient of several teaching and mentorship awards, including the Nevada Center for Technology and Entrepreneurship Faculty Advisor Award 2009, the UNR Outstanding Undergraduate Research Faculty Mentor Award 2011, and the UNR Donald Tibbitts Distinguished Teacher Award 2011.

DR. FRED HARRIS

Component Co-Lead

Dr. Fred Harris will lead the team on software engineering and human-computer interaction in the cyberinfrastructure (CI) component. He proposes that new software practices and tools can streamline CI engineering and facilitate scientific and education work.

The team will define a process model to guide future CI developments that support data-intensive research and will also develop new software tools and services to facilitate nexus research.



DR. DALE DEVITT

Component Co-Lead

Dr. Dale Devitt is a soil and water scientist who focuses his research on soil plant water relationships in arid environments. Much of his research has addressed osmotic and matric interactions on plants, with special emphasis on irrigated systems with poor quality water. He currently is the UNLV water component lead of the NSF EPSCoR climate change study in which two transects comprised of sophisticated weather stations are being placed on two mountain ranges in Nevada.

He is also the director of the Center for Urban Water Conservation that conducts both applied and basic research related to urban water-related issues. A current study is investigating the fate and transport of pharmaceuticals in turf grass systems irrigated with recycled water.

Devitt received his bachelor's degree in environmental science, his master's degree in soil science and his doctorate in soil science from the University of California Riverside. He is the author of 72 peer-reviewed publications and one book.

DR. MARY CABLK

Component Co-Lead

Dr. Mary Cablk has two focal areas on the Nexus project within the environmental area and external engagement. The focus of the environmental area is to study the impacts of solar facilities on the environments. These studies will help minimizing the environmental impacts of construction, operation and decommission of solar facilities in desert environments. Cablk will study the impact of solar facilities on landscape patterns: investigate landscape pre- syn- and post-installation using remote sensing techniques.



DR. MARKUS BERLI

Component Co-Lead

Dr. Markus Berli is an associate research professor for environmental hydrogeophysics at the Desert Research Institute in Las Vegas.

Berli has 17 years of experience in basic and applied research related to the physics, mechanics and hydraulics of soils and soft rocks. His research focuses on modeling and measurement of soil structural dynamics affecting fluid flow and solute transport. Key issues are the connection of hydraulics and mechanics of soils at the micro-scale and upscaling physical soil behavior from pore to sample and eventually field-scale.

Berli's research projects encompass a range of topics, from the physics and mechanics of root-soil interactions and water and energy balance of arid soils, to prediction of post-fire flooding and debris flow. His research has been funded by the Swiss National Science Foundation, USDA, US-NSF, DOD and DOE.

Berli currently leads the NSF-EPSCoR-funded project on scaling environmental processes in heterogeneous arid soils (SEPHAS; dri.edu/sephas). Since fall 2012, he has also served as acting co-director of DRI's Clean Technology and Renewable Energy Center (CTREC; dri.edu/ctrec).

Berli holds a master's degree and a doctorate in civil and environmental engineering from the Swiss Federal Institute of Technology Zurich (ETHZ), Switzerland.

DR. JACQUE EWING-TAYLOR

Component Lead

Dr. Jacque Ewing-Taylor is the education workforce component lead for the Nexus project. She leads a team who will develop a sustainable science, technology, engineering, and mathematics (STEM) workforce by creating a pipeline of STEM-trained students, educators and workers, while increasing public understanding of solar energy, water, and the environment.

Ewing-Taylor is the associate director at Raggio Research Center for STEM Education at the University of Nevada, Reno.



LORI BRAZFIELD

Nevada System of Higher Education, Nevada EPSCoR
Director, Sponsored Programs and EPSCoR office

As the director of sponsored programs and the EPSCoR Nevada office, Lori Brazfield administers \$25 million per year in federal and state agency awards for programs such as the Solar Nexus Project.

In her position with the Nevada System of Higher Education, she supervises 10 staff members for both pre-award and post-award in Las Vegas; negotiates federal, state and intra-inter institutions grants and contracts; provides policy interpretation and guidance relating to grants and contracts with all parties to the award; and more. She has been an invited industry speaker and panelist on numerous occasions.

Brazfield graduated from UNLV with her bachelor's degree in communication studies and summa cum laude from Trident University International with her MBA. She has also earned her Practice of Research Administration and Management Program certificate. She is a member of the Intermountain University Research Administrators, the Society of Research Administrators International and the National Council of University Research Administrators. During her career, she has successfully written numerous grant initiatives resulting in millions of dollars in funding for Nevada.

MICHELE CASELLA

Diversity Plan Lead

Michele Casella is the education, outreach and diversity administrator (EOD) for the Nevada System of Higher Education Sponsored Programs Office (NSHE SPO). In this role, she is responsible for ensuring that EOD activities are integrated throughout the three NSF EPSCOR projects currently funded in Nevada.

Through NSF-funded programs, Casella works collaboratively with other research-based projects to provide continuity in STEM education and research and to build a more diverse STEM workforce.

In 2002, Casella received her bachelor's degree in education from the University of Nevada, Las Vegas. Her formal education and professional experience working for state and federal agencies, as well as for-profit and non-profit organizations, has made Casella successful in planning, implementing and evaluating pathway programs for traditional and non-traditional students in a variety of different disciplines.



MARCIE JACKSON

Project Administrator

Marcie Jackson joined the Nevada System of Higher Education Special Sponsored Programs Office in December 2011. She is responsible for the budget, finance, and cradle-to-grave grants management of Nevada's two Research Infrastructure Improvement (RII) awards, which total more than \$22 million in federal dollars and more than \$6.5 million in state dollars.

Jackson brings more than 13 years of grant proposal development and grant administration experience to NSHE and has a varied background in higher education, business, civil service, and non-profit management. She holds a master of public administration degree from UNLV and is a member of the National Council of University Research Administrators and the Society of Research Administrators International.